Micromouse

Big Rat
November 21, 2020
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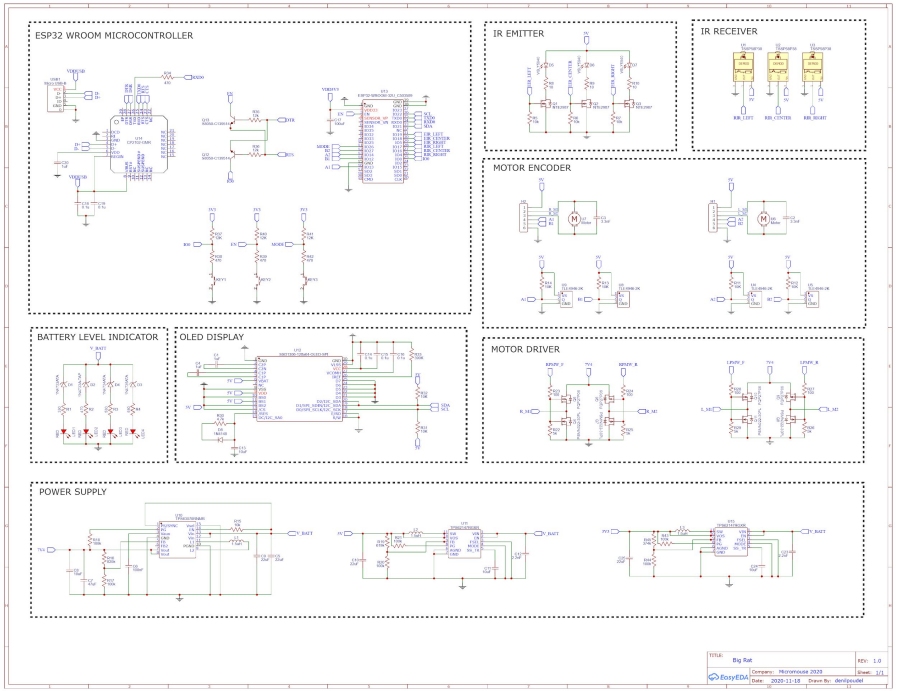
Agenda

- Overview
- Design - Microprocessor
- Design - Wall Detection
- Design - Motor Control
- Design - Power
- Design - Algorithm
- BoM
- Schematic



Big Rat Overview

Dimensions:

Width: 100mm
Length: 80mm

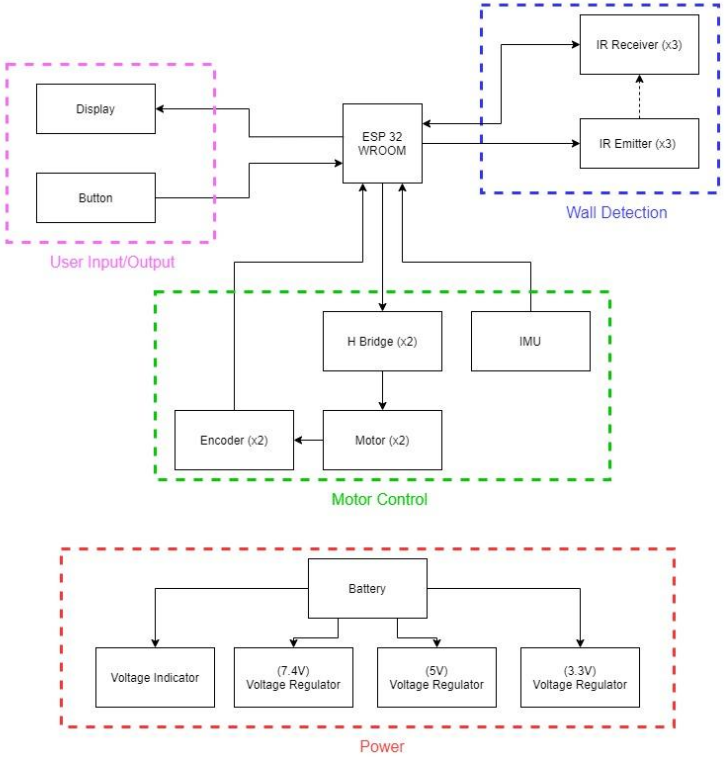
Hardware:

MPU: ESP32 @240MHz

IR Emitter: VSLY5940 (940nm)
IR Receiver: TSSP58P38 (940nm)

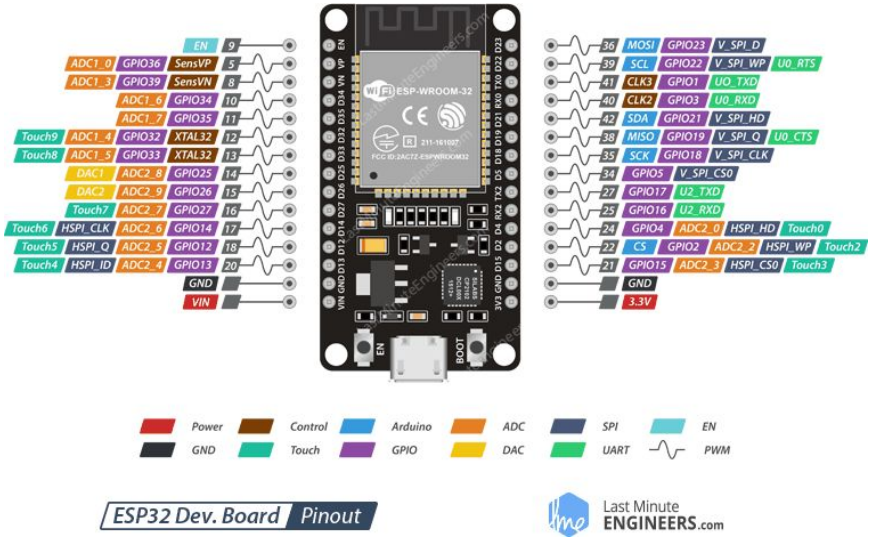
Motor: 75:1 Micro Metal Gearbox 6V
Encoder: 12 Count Magnetic

Battery: RDQ 7.6 2s 650mAH LiPo
Power: TPS63070RNMR @ 7.4V 2A
TPS62147RGXR @ 5.0V 2A
TPS62147RGXR @ 3.3V 1A



Big Rat Design - Microprocessor

- ESP32
  - Architecture: 32 bit
  - Clock: 240MHz
  - Core: 2
  - PWM: 16 Channels
    - MAX: 40MHz
- Arduino Nano
  - Architecture: 16 bit
  - Clock: 16MHz
  - Core: 1
  - PWM: 6 Channels
    - MAX: 490Hz



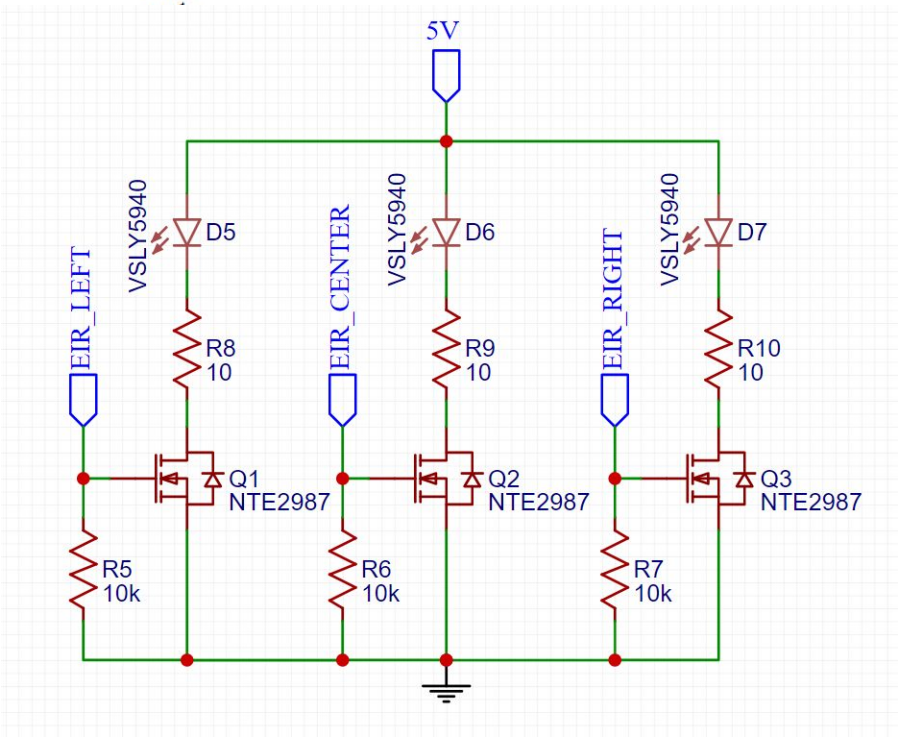
Big Rat Design - Wall Detection (IR Emitter)

- VSLY5940
  - Wavelength: 940nm
  - Radiant Intensity @ 100mA: 600 mW/sr
  - Degree: ± 3°

t_p	MAX I_P	T	Duty Cycle D = tp/T	Pulsing Frequency
ms	mA	ms		Hz
0.01	300	0.026	0.3846153846	38,462

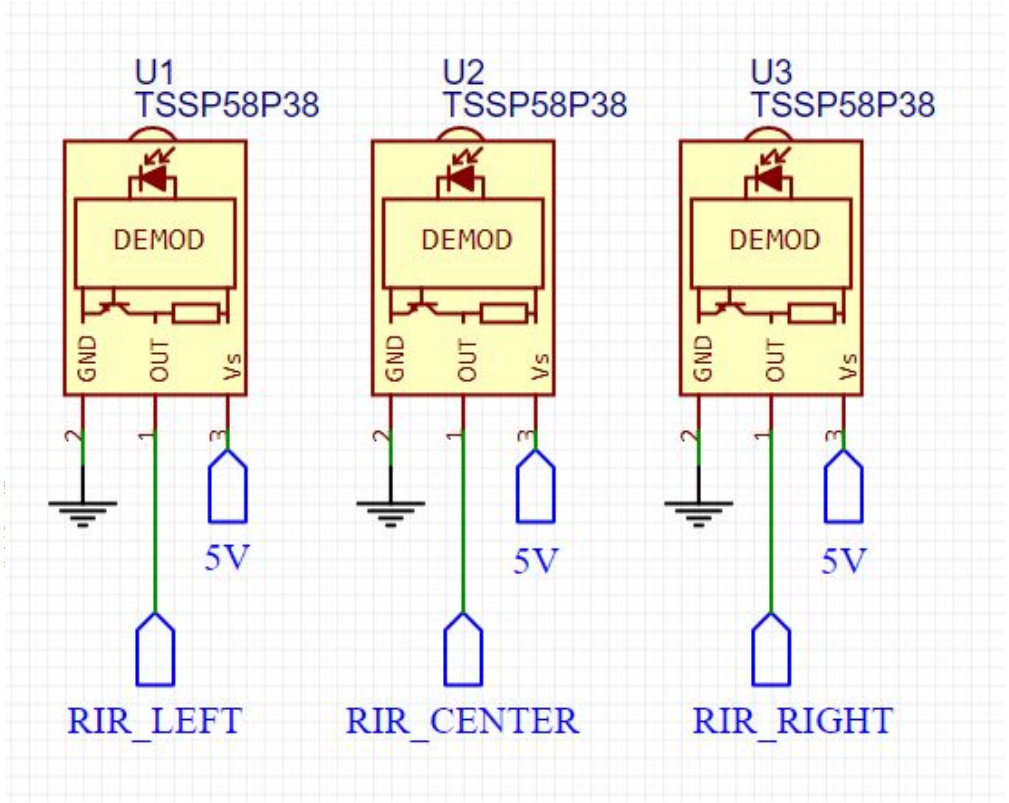
- TSAL6100
  - Wavelength: 940nm
  - Radiant Intensity @ 100mA: 170 mW/sr
  - Degree: ± 10°

t_p	MAX I_P	T	Duty Cycle D = tp/T	Pulsing Frequency
ms	mA	ms		Hz
0.01	400	0.026	0.3846153846	38,462



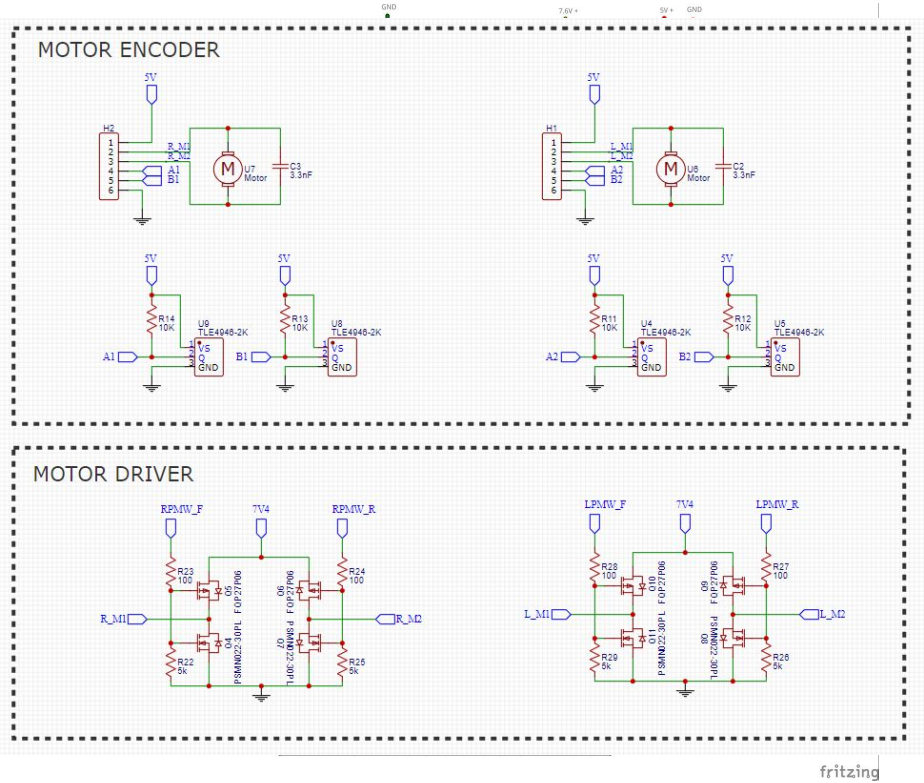
Big Rat Design - Wall Detection (IR Receiver)

- TSSP58P38
  - Wavelength: 940nm
  - Degree: ± 45°
  - Receives 38kHz modulated signal
- LTR-209
  - Wavelength: 940nm
  - Degree: ± 16°
  - Low Collector Current vs Irradiance
- 1540051NC2590
  - Wavelength: 940nm
  - Degree: ± 25°
  - High Collector Current vs Irradiance
    - Need to filter excess noise
      - OP-AMP needs ± 5V



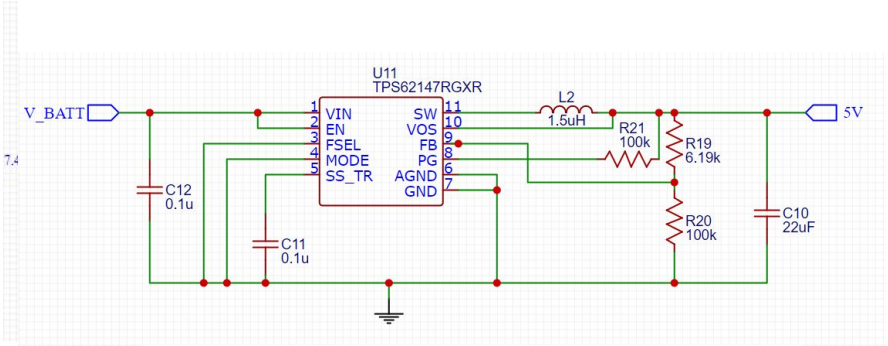
Big Rat Design - Motor Control

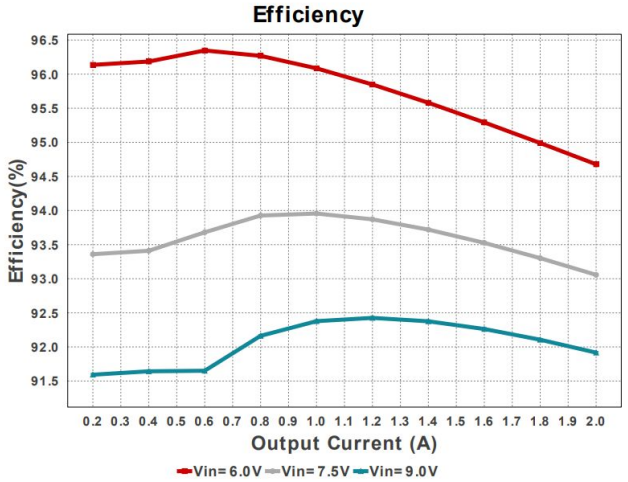
- H-Bridge
  - Discrete H-Bridge
  - L298N [Backup]
- Micro Metal Motor
  - Brushed DC 6V
  - 1:75 Gearbox
  - Length: 45 mm
- Magnetic Encoder
  - 12 Count [900 Count w/ Gearbox]
- Digital Control System
  - Arduino PID Library [ESP32 Compatible]
    - Store data to EEPROM
    - Plot data in Python



Big Rat Design - Power

- RDQ 7.6 2s 650mAH LiPo
  - Dimensions: 63x17x16 mm
  - Runtime: 15 min
- Battery Level Indicator
  - LEDs will turn off below 8V, 7.4V, 6.9V, 6.5V.
- TPS63070RNMR
  - Buck Boost
  - Input: 6V - 9V
  - Output: 7.4V 2A
- TPS62147RGXR
  - Buck
  - Input: 6V - 9V
  - Output1: 5V 2A
  - Output2: 3.3V 1A





Big Rat Design - Algorithm

- MMS Simulator
  - Simulation testing C++ Algorithm
  - Allows parallel development

- Breadth First Search
  - Algorithm:
    - Selects initial point in graph
    - Visits all adjacent nodes to the selected
    - Continues until all nodes in graph is visited and marked
  - Simplest to implement
    - Does not have the fastest run time
  - Will eventually switch algorithms
    - A*
    - Flood Fill
    - Dijkstra's

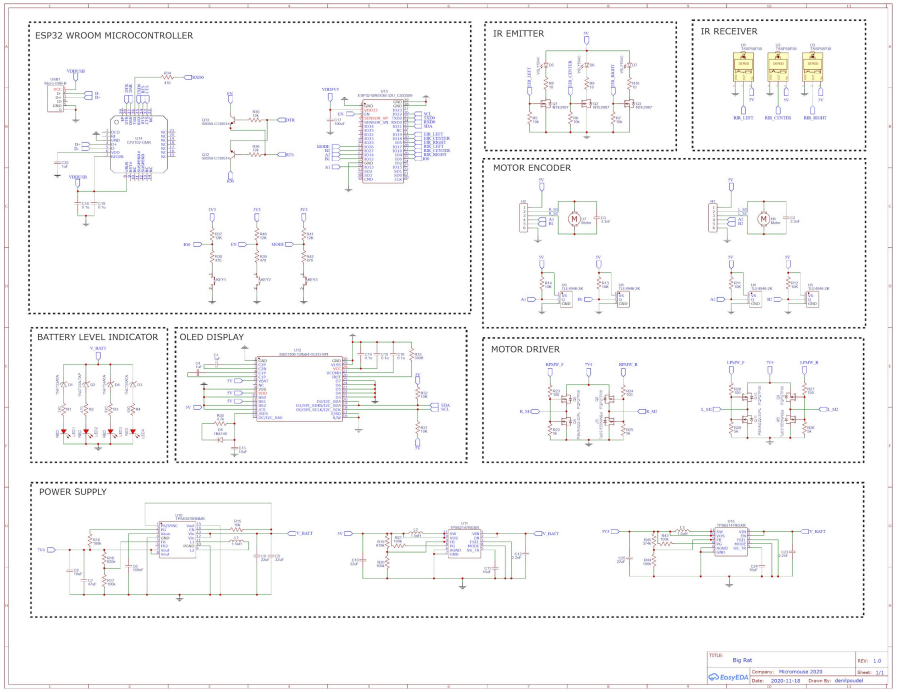
```
queue<Point> coordinates;
Point start(15, 1);
coordinates.push(start);

while (!coordinates.empty()) { //!coordinates.empty()
  Point removed = coordinates.front();
  coordinates.pop();
  if (checkCenter(removed) == true) {
    break;
  }
  if ((!API::wallFront()) && visited[removed.getX() - 1][removed.getY()] == 0 && visited[removed.getX() - 1][removed.getY()] != 2)
    API::moveForward(1);
    log("going forward...");
    visited[removed.getX() - 1][removed.getY()] = 1;
    Point path(removed.getX() - 1, removed.getY());
    coordinates.push(path);
    continue;
  }

  if ((!API::wallLeft()) && visited[removed.getX()][removed.getY() - 1] == 0 && visited[removed.getX()][removed.getY() - 1] != 2) {
    API::turnLeft();
    //API::moveForward(1);
    log("turning left...");
    visited[removed.getX()][removed.getY() - 1] = 1;
    Point path(removed.getX(), removed.getY() - 1);
    coordinates.push(path);
    continue;
  }

  if ((!API::wallRight()) && visited[removed.getX()][removed.getY() + 1] == 0 && visited[removed.getX()][removed.getY() + 1] != 2)
    API::turnRight();
    //API::moveForward(1);
    log ("turning right...");
    visited[removed.getX()][removed.getY() + 1] = 1;
    Point path(removed.getX(), removed.getY() + 1);
    coordinates.push(path);
    continue;
  }

  if (API::wallRight() && API::wallLeft() && API::wallFront()) {
    API::turnRight();
    API::turnRight();
    API::moveForward(1); //not right
    continue;
  }
 }
}
```

Big Rat - BoM

- Bill Of Material
  - All Parts Available from Mouser
  - 46 Different Components
    - Mix of THT and SMT
      - Eventually all will be SMT
- Total Cost of Components: ~$120.06
  - Some components out of stock
    - Working on finding alternatives
- PCB Fabrication
  - Custom Home PCB Fabrication by Denil
    - JLCPCB - $10 for 5 Boards
      - 3-5 Day Turn Around
      - 4 Weeks Shipping

Num	Technology	Type	Value	Qty	Min Order	Price	Total	Data Sheet	Buy Link
21	THT	BJT	S8050	2	1	$0.30	$0.60	https://www.mou	https://www.mou
6	THT	Capacitor	3.3nF	2	1	$0.43	$0.86	https://www.mou	https://www.mou
7	THT	Capacitor	22uF	4	1	$0.29	$1.16	https://www.mou	https://www.mou
8	THT	Capacitor	47uF	1	1	$0.19	$0.19	https://www.mou	https://www.mou
9	THT	Capacitor	10uF	5	1	$0.30	$1.50	https://www.mou	https://www.mou
10	THT	Capacitor	2.2nF	2	1	$0.63	$1.26	https://www.mou	https://www.mou
11	THT	Capacitor	1uF	4	1	$0.30	$1.20	https://www.mou	https://www.mou
12	THT	Capacitor	0.1uF	4	1	$0.65	$2.60	https://www.mou	https://www.mou
13	THT	Capacitor	2uF	1	1	$0.13	$0.13	https://www.mou	https://www.mou
14	THT	Capacitor	100uF	1	1	$0.29	$0.29	https://www.mou	https://www.mou
45	THT	Diode	1N4148	1	1	$0.10	$0.10	https://www.mou	https://www.mou
2	THT	Diode, LED	RED	4	1	$0.54	$2.16	https://www.mou	https://www.mou
4	THT	Diode, Zener	1N4735A-TAP	1	1	$0.37	$0.37	https://www.mou	https://www.mou
17	THT	Diode, Zener	1N4734ATA	1	1	$0.31	$0.31	https://www.mou	https://www.mou
23	THT	Diode, Zener	1N4732ATA	1	1	$0.31	$0.31	https://www.mou	https://www.mou
24	THT	Diode, Zener	1N4733A-TAP	1	1	$0.31	$0.31	https://www.mou	https://www.mou
3	SMT	Hall Effect	TLE4946-2K	4	1	$0.92	$3.68	https://www.infin	https://www.mou
1	SMT	Hardware	Switch	3	1	$0.52	$1.56	https://www.mou	https://www.mou
15	SMT	Hardware	Micro USB-B	1	1	$0.83	$0.83	https://www.mou	https://www.mou
18	THT	Hardware	Micro Metal Motor 75:1	2		$16.95	$33.90		https://www.polo
5	SMT	IC	TPS63070RNMR	1	1	$2.60	$2.60	https://www.ti.co	https://www.mou
25	SMT	IC	CP2102-GMR	1	1	$3.17	$3.17	https://www.mou	https://www.mou
27	SMT	IC	ESP32-WROOM-32U_C503589	1	1	$2.80	$2.80	https://www.mou	https://www.mou
44	SMT	IC	TPS62147RGXR	2	1	$1.98	$3.96	http://www.ti.com	https://www.mou
46	SMT	IC	SSD1306-128x64-OLED-SPI	1	1	$12.80	$12.80	https://www.mou	https://www.mou
26	THT	Inductor	1.5uH	3	1	$0.25	$0.75	https://www.mou	https://www.mou
22	THT	IR Emitter	VSLY5940	3	1	$1.48	$4.44	https://www.mou	https://www.mou
16	THT	IR Reciver	TSSP58P38	3	1	$1.75	$5.25	https://www.mou	https://www.mou
19	THT	MOSFET, Logic Level	NTE2987	3	1	$1.80	$5.40	https://www.mou	https://www.mou
20	THT	MOSFET, Power N	PSMN022-30PL	4	1	$0.76	$3.04	https://www.mou	https://www.mou
28	THT	MOSFET, Power P	FQP27P06	4	1	$1.40	$5.60	https://www.mou	https://www.mou

Questions?



[Schematic]